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(71) Applicant(s)
Uponor Limited
(Incorporated in the United Kingdom)
PO Box 1, Hilcote Plant, Blackwell, NR ALFRETON,
Derbyshire, DE55 5JD, United Kingdom

(72) Inventor(s)
Jeremy Archibald Bowman

(74) Agent and/or Address for Service
Dibb Lupton Alsop
Fountain Precinct, Balm Green, SHEFFIELD, S1 1RZ,
United Kingdom

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(56) Documents Cited
GB 2300457 A GB 2272039 A GB 2264765 A
GB 1310915 A

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(54) Abstract Title
Lining a pipe

(57) A pipe is lined by

a) extruding and cross-linking a lining pipe ("the liner") of thermoplastics material and having a first diameter of smaller diameter than that of the pipe to be lined;

b) inserting the liner into the pipe to be lined;

c) heating the liner above its crystalline melting point; and

d) causing the liner to expand into contact with pipe to be lined.

e) cooling the expanded liner to below its crystalline melting point.

The liner may then be reheated to above its crystalline melting point thereby allowing the liner to return to the first diameter, the pipe depressurised, the liner again heated to above its crystalline melting point and caused to re-expand into contact with the pipe and the pipe finally repressurised.

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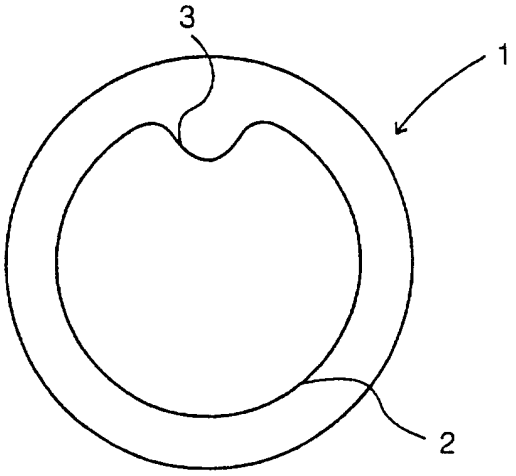

Fig. 1A
(Prior Art)

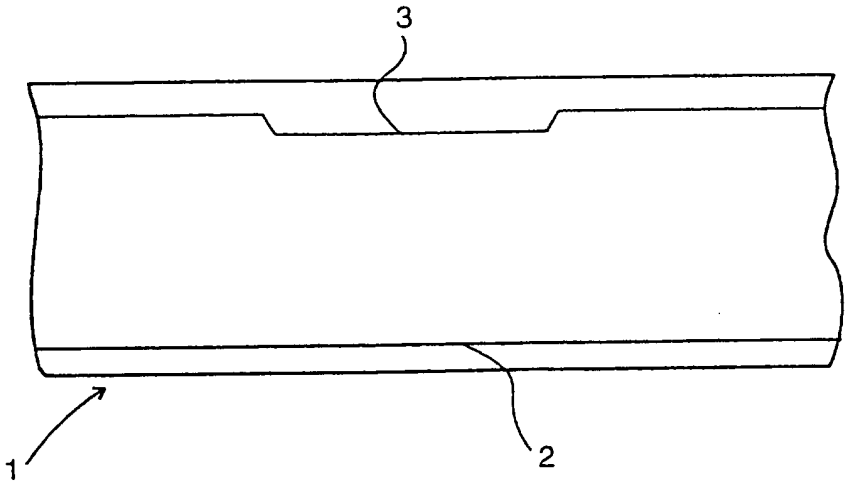

Fig. 1B
(Prior Art)

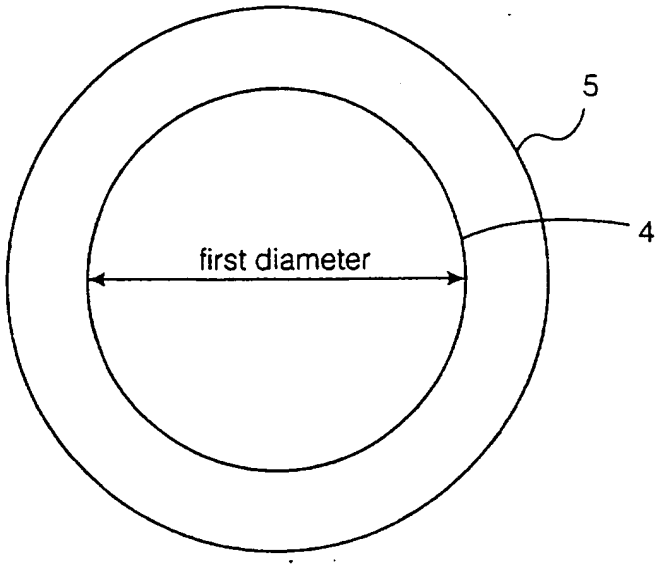

Fig. 2

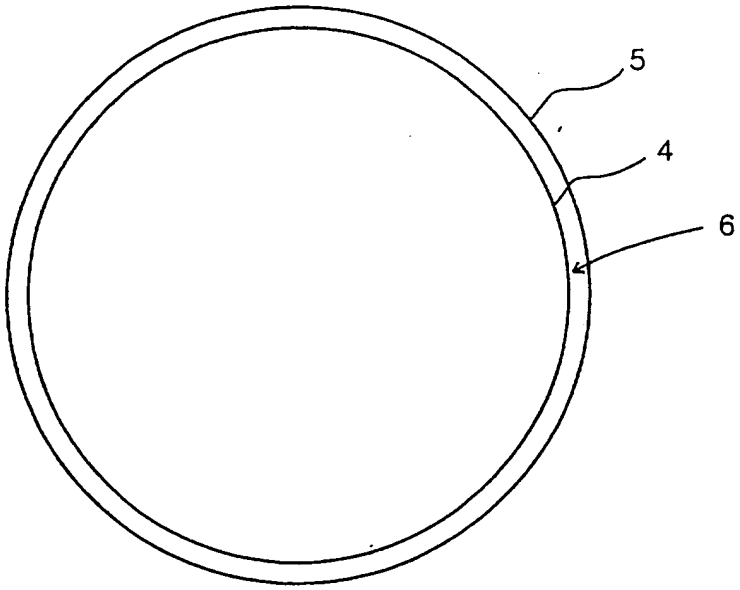

Fig. 3

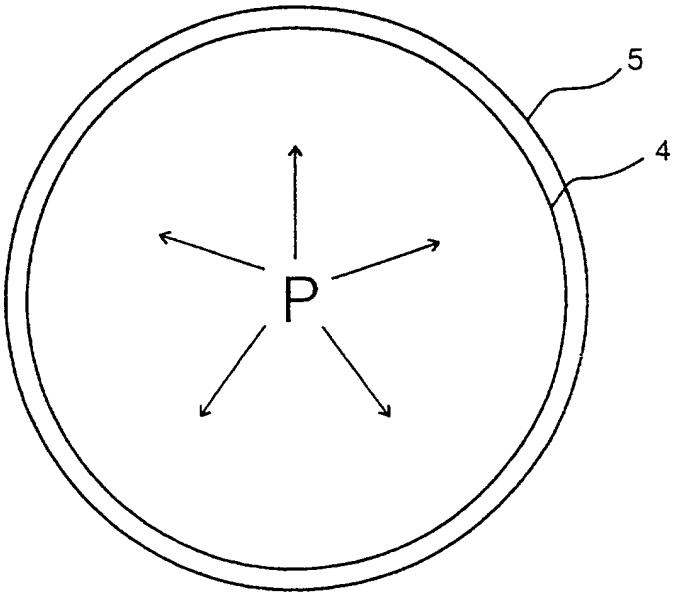

Fig. 4

LINING A PIPE

This invention relates to a liner pipe of thermoplastic material for lining offshore pipes and a method of lining a pipe with such a liner.

A number of methods are known for using polyethylene liners to refurbish pipelines and some of these are summarised in GB2324846A, which document also identifies some of the problems associated with those methods.

Liner technology is particularly important in relation to pressurised offshore pipelines wherein a high performance liner is required to withstand the hostile environment caused by, for example, the passage of aggressive hydrocarbons or wet acid gas. The method of installing the liner in the pipe is also a prime consideration.

GB2324846A describes a method of lining a pipe comprising

a) inserting into the pipe to be lined a lining pipe of thermoplastics material, the lining pipe being of smaller diameter than the pipe to be lined, and the thermoplastics material incorporating a cross-linking agent,

b) causing the lining pipe to expand into contact with the pipe to be lined, and

c) cross-linking the thermoplastics material.

This method is advantageous in that the liner is cross-linked after it has been introduced into the pipe. The liner initially has a smaller diameter than the existing pipe and is therefore relatively easy to introduce, without the need for complex and expensive equipment.

The act of cross-linking in situ causes the liner to set at the diameter of the existing pipe. The liner may also adhere or bond to the internal surface of the existing pipe, giving a considerable increase in stability and reducing corrosion at the annular interface. In addition, no large and costly equipment is required for reduction of the liner diameter prior to installation of the liner.

However, this and other methods of lining a pipe are prone to the disadvantage that, once installed, the liner is vulnerable to deformity caused by depressurisation of the pipeline. This problem is discussed in a paper entitled "Structural Considerations for Thermoplastics Pipe Linings used for the Transport of Aggressive Hydrocarbons" by J. C. Boot and M. M. Naqui, presented at the conference PLASTICS PIPES X, "Plastics Pipeline Systems for the Millenium" held 14-17 September 1998 in Göteborg (SE).

Under normal operating conditions, the liner is subject to compressive stresses and fluids can diffuse through the polymeric liner pipe so that fluids build up at the interface between the liner and the pipeline.

When depressurisation of the pipeline occurs (for example during maintenance), the fluid at the annular interface is at full operating pressure and the liner is liable to buckle or crumple.

On repressurisation of the pipeline, there is no guarantee that the liner will return to its original shape. Irreversible deformity of the liner causes areas

of particular weakness, which may result in failure of the liner, after which the pipeline is exposed to corrosion and flow capacity may be adversely affected.

Such a failure, even if it does not result in damage to the main pipeline (which it may well do), will at least require costly removal and replacement of the liner.

There is thus a need for a liner which, on depressurisation of the pipeline, does not irreversibly deform. The present invention seeks to overcome this problem.

Summary of the Invention

According to a first aspect of the present invention, there is provided a method of lining a pipe comprising the steps of

a) extruding and cross-linking a lining pipe ("the liner") of thermoplastics material and having a first diameter of smaller diameter than that of the pipe to be lined;

b) inserting the liner into the pipe to be lined;

c) heating the liner to above its crystalline melting point; and

d) causing the liner to expand into contact with the pipe to be lined.

e) cooling the liner in the expanded form.

The liner, by virtue of being cross-linked, will have a memory of the original small ("first") diameter.

Preferably, the method comprises the further steps of

a) re-heating the liner to above its crystalline melting point, thereby allowing the liner to return to the first diameter, substantially retaining its cross-sectional shape;

b) depressurising the pipe, for example for maintenance;

c) heating the liner again to above its crystalline melting point;

d) causing the liner to re-expand into contact with the pipe; and

e) repressurising the pipe.

Preferably, the liner is expanded by passing water down the liner.

According to a second aspect of the present invention, there is provided a lining pipe ("a liner") for use in the method substantially as described above.

Preferably, the liner is of a cross-linkable polyolefin.

Preferably, the liner is of cross-linkable polyethylene.

Brief Description of the Drawings

Preferred embodiments of the invention will now be more particularly described, by way of example only, with reference to the accompanying drawings in which:

Figure 1a is a cross-section of a prior art pipeline and liner, showing the deformed liner after de-pressurisation;

Figure 1b is a longitudinal section of the pipeline and

liner of Figure 1a;

Figures 2-4 show cross-sections of a pipeline and liner according to the present invention, at various stages as described below.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

It is known to line a pipeline 1 with a thermoplastics liner 2 and Figures 1a and 1b show how a deformity 3 can appear in a prior art liner 2 on depressurisation of the pipeline 1.

On repressurisation of the pipeline 1, the liner 2 may remain deformed causing the problems outlined above.

Referring now to Figures 2-4, these problems are alleviated by the following method and apparatus.

A lining pipe ("the liner") 4 is extruded from thermoplastics material to have a diameter ("a first diameter") smaller than the diameter of a pipe 5 to be lined.

The liner 4 is cross-linked at this first diameter.

The liner 4 is then inserted into the pipe to be lined 5 using known techniques, as shown in figure 2.

Once the liner is located inside the pipe 5, the liner is heated, by passing hot oil along it to a temperature above its crystalline melting point, and typically 5 to 50°C above the crystalline melting point. Now, it can be expanded (using known techniques)such as pressurisation

against the internal surface of the pipe 5, as shown in figure 3. The liner 4 is then cooled and frozen in this position, thus providing a close-fitting liner for the pipe 5.

When in service, the pipe 5 is pressurised as indicated in Figure 4. Given the nature of the liner, fluids can diffuse through the liner and build up at the interface 6 between the liner 4 and pipe 5. This build-up of pressurised fluid is what would normally lead to deformation of the liner on depressurisation of the pipe 5 (as described above).

However, according to the present invention, when a depressurisation of the pipe 5 is likely (or planned) to occur, the following action is taken to avoid such deformation.

The liner 4 is heated to a temperature beyond its crystalline melting point which enables the cross-linked liner to revert to its first diameter (i.e. the diameter smaller than that of pipe 5) if the pressure inside the liner is slowly reduced. This is represented in Figure 2. This releases the pressure build-up at the liner-pipe interface 6, without any deformation of the liner 4.

Before repressurisation of the pipe, the liner 4 needs to be reheated and expanded against the internal surface of the pipe 5. The same expansion technique can be used as when the liner 4 was first inserted to the pipe 5 (as described with respect to Figure 3).

Once the liner has been cooled and refrozen in the

expanded position, the pipe 5 can be repressurised and normal service operation can be resumed, as shown in Figure 4.

In this way, the liner 4, having a built-in memory, alleviates the problems associated with gas-build up between the pipe 5 and liner by retaining its cross-sectional shape substantially without deformation.

Furthermore, the PE-X liner has good high temperature (40-100°C) strength and very good resistance to attack by aggressive fluids.

CLAIMS

1. Method of lining a pipe comprising the steps of

a) extruding and cross-linking a lining pipe ("the liner") of thermoplastics material and having a first diameter of smaller diameter than that of the pipe to be lined;

b) inserting the liner into the pipe to be lined;

c) heating the liner above its crystalline melting point; and

d) causing the liner to expand into contact with pipe to be lined.

e) cooling the expanded liner to below its crystalline melting point.

2. Method according to claim 1 comprising the further steps of

a) re-heating the liner to above its crystalline melting point, thereby allowing the liner to return to the first diameter, substantially retaining its cross-sectional shape;

b) depressurising the pipe, for example for maintenance;

c) heating the liner again to above its crystalline melting point;

d) causing the liner to re-expand into contact with the pipe; and

e) repressurising the pipe.

3. Method as claimed in claim 1 or claim 2 wherein the liner is caused to expand by passing water down the liner.

4. A lining pipe ("the liner") for use in the method of any of the preceding claims.

5. Liner as claimed in claim 4 wherein the liner is of a cross-linkable polyolefin.

6. Liner as claimed in claim 4 or claim 5 wherein the liner is of cross-linkable polyethylene.

7. A lining pipe ("the liner") substantially as described herein with reference to and as illustrated by any of Figures 2-4.

8. A method of lining a pipe substantially as described herein with reference to and as illustrated by any of Figures 2-4.

Amendments to the claims have been filed as follows

1. Method of lining a pipe comprising the steps of

a) extruding and cross-linking a lining pipe ("the liner") of thermoplastics material and having a first diameter of smaller diameter than that of the pipe to be lined;

b) inserting the liner into the pipe to be lined;

c) heating the liner above its crystalline melting point; and

d) causing the liner to expand into contact with pipe to be lined.

e) cooling the expanded liner to below its crystalline melting point so that it solidifies in its expanded state,

characterised in that the method further comprises the step of

f) re-heating the liner to above its crystalline melting point, thereby allowing the liner to return to the first diameter, substantially retaining its cross-sectional shape, so that, for example, maintenance can be carried out.

2. Method as claimed in claim 1 further comprising the step of depressurising the pipe.

3. Method as claimed in claim 1 or claim 2 further comprising the steps of

a) heating the liner again to above its crystalline melting point; and

b) causing the liner to re-expand into contact with the pipe.

4. Method as claimed in claim 3 when dependent on claim 2 further comprising the step of repressurising the pipe.

5. Method as claimed in any of claims 1-4 wherein the liner is caused to expand by passing oil or other suitable fluid down the liner.

6. A lining pipe ("the liner") for use in the method of any of the preceding claims.

7. Liner as claimed in claim 6 wherein the liner is of a cross-linkable polyolefin.

8. Liner as claimed in claim 6 or claim 7 wherein the liner is of cross-linkable polyethylene.

9. A lining pipe ("the liner") substantially as described herein with reference to and as illustrated by any of Figures 2-4.

10. A method of lining a pipe substantially as described herein with reference to and as illustrated by any of Figures 2-4.

The Patent Office

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Application No: GB 9911477.9
Claims searched: 1 to 8

Examiner: R.J.MIRAMS
Date of search: 29 September 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): F2P (PM9, PTBL).

Int Cl (Ed.6): B29C 63/34, 63/42. F16L 55/165.

Other: ONLINE: WPI, EPODOC, JAPIO.

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB1310915A	(Dunlop)	1 and 4 to 6
X	GB2300457A	(Uponor)	4 to 6
X	GB2272039A	(Uponor Aldyl)	4 to 6
X	GB2264765A	(British Gas)	4 to 6

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.